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(54) [Title of the Invention] Flexible non-halogen electric wire cable

(57) [Abstract]

[Problem] Using an olefin-based resin that does not contain a halide as the principle component, to suppress tear load and bending load and impart the prescribed tear load and the prescribed bending load whereby the tear characteristics are improved and the handling and processability can be improved.

[Solving Means] Configured by the foaming of a non-halogen flame-retardant sheath to cover a structural body formed from a pair of aligned insulated conductors in which an insulating body configured from a polyvinyl chloride resin or olefin-based resin is coated on the conductors, or to cover a structural body formed by the twisting of a plurality of said insulated conductors and the interposing of an inclusion.

[Scope of the Patent Claims]

[Claim 1] Flexible non-halogen electric wire cable formed by the foaming of a non-halogen flame-retardant sheath to cover a structural body formed from a pair of aligned insulated conductors in which an insulating body configured from a polyvinyl chloride resin or olefin-based resin is coated on the conductors, or to cover a structural body formed by the twisting of a plurality of said insulated conductors and the interposing of an inclusion.

[Claim 2] Flexible non-halogen electric wire cable according to Claim 1, wherein the abovementioned non-halogen flame-retardant sheath is formed by the compounding in the olefin-based resin of, at the least, a flame retardant and an organic chemical foaming agent and, in accordance with need, the compounding therein of other processing aids or an antioxidant, and the foaming thereof at a foaming rate of 5 to 20%.

[Claim 3] Flexible non-halogen electric wire cable according to Claim 1 or 2, wherein the abovementioned non-halogen flame-retardant sheath is formed by the compounding of, at the least, the flame retardant in the amount of 50 to 200 wt. parts and the organic chemical foaming agent in the amount of 0.2 to 5 wt. parts per 100 wt. parts of the olefin-based resin and, in accordance with need, the compounding therein of other processing aids or an antioxidant in appropriate amounts, and the foaming thereof at a foaming rate of 5 to 20%.

[Claim 4] Flexible non-halogen electric wire cable according to Claim 2 or 3, wherein the abovementioned olefin-based resin is one type or a mixture of two or more types of either a linear low density polyolefin, low density polyethylene, ethylene - vinyl acetate copolymer, ethylene - ethyl alkylate copolymer, ethylene - methyl methacrylate copolymer, ethylene - acrylic acid copolymer, ethylene - methacrylic acid copolymer, high density polyethylene, polypropylene, metallocene-based linear low

density polyethylene, metallocene very-low density polyethylene, ethylene - propylene copolymer or butadiene - acrylonitrile rubber.

[Claim 5] Flexible non-halogen electric wire cable according to Claim 2, 3 or 4, wherein the abovementioned flame retardant is one type or a mixture of two or more types of either magnesium hydroxide, aluminium hydroxide, zirconium hydroxide, calcium hydroxide, barium hydroxide, zinc borate, zinc metaborate, calcium carbonate, molybdenum oxide, red phosphorus, a phosphate ester, ammonium polyphosphate or potassium titanate.

[Claim 6] Flexible non-halogen electric wire cable according to Claim 2, 3, 4 or 5, wherein the dispersibility and moisture resistance of the abovementioned flame retardant is improved by the implementation of surface processing or coupling processing using, for example, a silane coupling agent, titanate coupling agent or various types of fatty acid (stearic acid or oleic acid).

[Claim 7] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5 or 6, wherein the abovementioned organic chemical foaming agent is one type or a mixture of two or more types of either azodicarbonamide, azobis(isobutyronitrile), dinitro pentamethylene tetramine, P-toluenesulfonyl hydrazide or 4, 4' - oxybis (benzenesulfonyl hydrazide).

[Claim 8] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, or 7, wherein the abovementioned organic chemical foaming agent compound is mixed as a master batch formed by the compounding of the organic chemical foaming agent with a mixture formed by the compounding in the olefin-based resin of the flame retardant and, in accordance with need, the compounding of other processing aids or an antioxidant.

[Claim 9] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7 or 8, wherein the abovementioned non-halogen flame-retardant sheath is formed

by the compounding in the olefin-based resin of, at the least, a flame retardant, silane coupling agent, cross-linking agent, cross-linking catalyst and organic chemical foaming agent, and the foaming at a foaming rate of 5 to 20% and cross-linking thereof.

[Claim 10] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7, 8 or 9, wherein the abovementioned organic chemical foaming agent compound is mixed as a master batch that is formed by the compounding of the organic chemical foaming agent, silane coupling agent, cross-linking agent and cross-linking catalyst in a compound formed by the compounding in the olefin-based resin of the flame retardant and, in accordance with need, the compounding of other processing aids or an antioxidant, and is then extrusion-covered to form a sheath.

[Claim 11] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7, 8, 9 or 10, wherein the abovementioned silane coupling agent is one type or a mixture of two or more types of either vinyl trimethoxy silane, vinyl triethoxy silane, vinyl methyl diethoxy silane or vinyl phenyl dimethoxy silane.

[Claim 12] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7, 8, 9, 10 or 11, wherein the abovementioned cross-linking agent is one type or a mixture of two or more types of either dicumyl peroxide, 2, 5 - (tertiary butyl peroxy)hexene - 3, or 1, 3 - bis(tertiary butyl peroxy isopropyl).

[Claim 13] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 or 12, wherein the abovementioned cross-linking agent is either dibutyltin dilaurate, dibutyltin dimaleate or dibutyltin methyl capsid.

[Claim 14] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, or 13, wherein the abovementioned processing aid is one or two

or more types of either methyl polymethacrylate, stearic acid or polyethylene wax.

[Claim 15] Flexible non-halogen electric wire cable according to Claim 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 or 14, wherein the abovementioned antioxidant is a hindered phenol-based antioxidant or a thiobis phenol-based antioxidant.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization] The present invention relates to a non-halogen electric wire cable in which a non-halogen flame-retardant sheath is mould-coated as an exterior layer on a structural body formed from a pair of aligned insulated conductors coated with an insulating body configured from an olefin-based resin or on a structural body formed by the twisting of a plurality of said insulated conductors and the interposing of an inclusion and, more particularly, it relates to a flexible non-halogen electric wire cable to which flexibility is imparted and the handling and processability thereof are improved.

[0002]

[Prior Art] Thermoplastic resin compositions are used in insulated power cables or the like in which insulating bodies or sheaths are formed on conductors or insulated electric wires due to their superior electrical properties, small dielectric constant and lower dielectric loss. Polyvinyl chloride resin compositions (halides) have been widely used hitherto as these thermoplastic resin compositions because they withstand voltage, have comparatively high insulation resistance, their production costs are low and, independently, they have very good flame resistance. However, in the use of the thermoplastic resin compositions of the prior art that employ polyvinyl chloride resin compositions such as this, hydrogen chloride gas, which has a corrosive property, is generated from the

polyvinyl chloride composition when, by way of example, the electric wire cable is burned during the disposal processing thereof by incineration. As a result, tests have been conducted in recent years in which olefin-based resin compositions such as polyethylene that do not employ a halide have been employed as insulating bodies or sheaths in electric wire cables in locations where high temperatures are produced such as wiring in buildings and the wire harness in vehicles. These olefin-based resin compositions are not, independently, flame resistant and so, in order to impart the prescribed flame resistance, a metal hydroxide such as magnesium hydroxide is mixed therewith.

[0003] That is to say, as an example of an insulated power cable of the prior art, as is shown in Figure 3, an insulated power cable 5 (for example a VVF cable) is configured by the aligning of a pair of insulated conductors 3 in which an insulating body 2 configured from a polyvinyl chloride resin or cross-linked polyethylene is coated on a conductor 1 configured from a soft copper wire, and the coating thereon of a sheath 4 configured from a non-halogen flame-retardant polyolefin. As an additional example of an insulated power cable of the prior art, as is shown in Figure 4, an insulated power cable 8 (for example a VVR cable) is configured by the twisting of a plurality of (three in Figure 4) the insulated conductors 3 in which the insulating body 2 configured from a polyvinyl chloride resin or cross-linked polyethylene is coated on a conductor 1 configured from a soft copper wire, the formation thereof in a round shape by the interposing of an inclusion 6, the winding around of a pressing wind tape 7, and the coating thereon of the sheath 4 configured from a non-halogen flame-retardant polyolefin. The non-halogen flame-retardant sheath, which constitutes the sheath 4 that forms the exterior layer of the insulated power cable 5 and insulated power cable 8, is extrusion-coated.

[0004] In the wiring of electric wire cables that employ a non-halogen flame-retardant sheath in the exterior layer in this way, to branch-connect the electric wire cable and connect the electric wire cable to a terminal or the like, a terminal processing of the electric wire cable performed by the individual carrying out the wiring work. The implementation of this terminal processing by the individual carrying out the electric wiring work involves an operation in which the sheath of the electric wire cable is peeled off and separated to expose the insulated conductors. In the operation to expose the insulated conductors a cutter knife is used to cut into the sheath between the two insulated conductors to divide the two insulated conductors, wherein the sheath is then cut off in the longitudinal direction of the sheath and peeled off. However, when, as an environmental measure or accident prevention measure, non-halogen olefin-based resin compositions such as polyethylene are used for the sheath of the electric wire or cable, because the tear load and bending load thereof are significantly harder and the flexibility thereof is inferior in comparison to electric wire cables in which PVC (polyvinyl chloride resin) is employed, the sheath is difficult to tear and the electric wire cable is difficult to bend during the operation to peel the sheath off to lay the wires, and the handling and processability of these electric wire cables is poor. Thereupon, flexibility has hitherto been imparted to electric wire cables that employ a non-halogen by the employment of metallocene catalyst-based olefin resin, the employment of elastomer components such as EPM (ethylene propylene copolymer, hereafter the same) or NBR (butadiene acrylonitrile rubber, hereafter the same), and the use of a comparatively flexible ethylene - vinyl acetate copolymer (EVA).

[0005]

[Problems to be Solved by the Invention] However, although flexibility can be imparted to sheaths that employ a metallocene catalyst-based olefin resin, elastomer components such as EPM (ethylene propylene copolymer, hereafter the same) or NBR (butadiene acrylonitrile rubber, hereafter the same) and that use a comparatively flexible ethylene - vinyl acetate copolymer (EVA), an inherent problem exists therein in that when, by way of example, a cutter knife is used to cut between the two insulated conductors to divide the two insulated conductors and an effort is made to cut the sheath in the longitudinal direction and peel it off, the sheath is difficult to tear in a constant direction and has extremely poor tear characteristics.

[0006] The objective of the present invention is, using an olefin-based resin that does not contain a halide as the principle component, to suppress tear load and bending load and impart the prescribed tear load and the prescribed bending load whereby the tear characteristics are improved and the handling and processability can be improved.

[0007]

[Means to Solve the Problems] In order to achieve the abovementioned objectives, the flexible non-halogen electric wire cable according to Claim 1 is configured by the foaming of a non-halogen flame-retardant sheath to cover a structural body formed from a pair of aligned insulated conductors in which an insulating body configured from a polyvinyl chloride resin or olefin-based resin is coated on the conductors, or to cover a structural body formed by the twisting of a plurality of said insulated conductors and the interposing of an inclusion. The non-halogen flame-retardant sheaths are used for coating on a pair of aligned insulated conductors (for example, a VVF cable) and for coating on a structural body in which a plurality (for example, three) of insulated conductors twisted (for example, a VVR cable) and an inclusion is

interposed therein to form a round shape. In addition, the non-halogen flame-retardant sheath is extrusion-coated on the surface of a structural body formed from a pair of insulated conductors on which an insulating body has been extrusion-coated or is extrusion-coated on a structural body formed in a round shape by the twisting of three insulated conductors on which an insulating body has been extrusion-coated and the interposing of an inclusion. A foaming agent is compounded in the non-halogen flame-retardant sheath and the coated sheath is foamed by the extrusion-coating heat produced during the extrusion-coating process.

[0008] Based on the invention according to Claim 1 configured in this way, using an olefin-based resin that does not contain a halide as the principle component, the tear load and bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted whereby the tear characteristics are improved and the handling and processability can be improved.

[0009] In order to achieve the above-noted objective, the flexible non-halogen electric wire cable according to Claim 2 is formed by the compounding in the olefin-based resin of, at the least, a flame retardant and an organic chemical foaming agent and, in accordance with need, the compounding therein of other processing aids or an antioxidant, and the foaming thereof at a foaming rate of 5 to 20%. The effectiveness of the organic chemical foaming agent is demonstrated at a sheath foaming rate of 5 to 20% and, ideally, at 7 to 15%. The reason a sheath foaming rate of 5 to 20% is adopted is because tear characteristic improvement cannot be expected if the sheath foaming rate is less than 5% and because, if the sheath foaming rate exceeds 20%, the tensile strength thereof falls below the required strength. The reason the ideal foaming rate is taken to be 7 to 15% is because, at this foaming rate, the appropriate tensile strength can be produced and the

optimum effectiveness thereof can be demonstrated whereby the tear characteristics can be improved in such a way that the cutter knife is able to cut into the sheath and the insulated conductors are able to be held so that the sheet can be opened to the left and right and torn easily.

[0010] Based on the invention according to Claim 2 configured in this way, using an olefin-based resin that does not contain a halide as the principle component, the tear load and bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted whereby the tear characteristics are improved and the handling and processability can be improved.

[0011] In order to achieve the above-noted objective, the abovementioned non-halogen flame-retardant sheath of the flexible non-halogen electric wire cable according to Claim 3 is formed by the compounding of, at the least, a flame retardant in the amount of 50 to 200 wt. parts and an organic chemical foaming agent in the amount of 0.2 to 5 wt. parts per 100 wt. parts of the olefin-based resin and, in accordance with need, the compounding therein of other processing aids or an antioxidant in appropriate amounts, and the foaming thereof at a foaming rate of 5 to 20%. In addition, in order to achieve the above-noted objective, the abovementioned olefin-based resin of the flexible non-halogen electric wire cable according to Claim 4 is configured from one type or a mixture of two or more types of either a linear low density polyolefin (LLDPE), low density polyethylene (LDPE), ethylene - vinyl acetate copolymer (EVA), ethylene - ethyl alkylate copolymer (EEA), ethylene - methyl methacrylate copolymer (EMM), ethylene - acrylic acid copolymer, ethylene - methacrylic acid copolymer, high density polyethylene (HDPE), polypropylene (PP), metallocene-based linear low density polyethylene (metallocene-based LLPDE), metallocene very-low density polyethylene (metallocene-based VLDPE), ethylene - propylene copolymer (EPA) or butadiene - acrylonitrile

rubber (NBR). In addition, in order to achieve the above-noted objective, the abovementioned flame retardant of the flexible non-halogen electric wire cable according to Claim 5 is configured from one type or a mixture of two or more types of either magnesium hydroxide, aluminium hydroxide, zirconium hydroxide, calcium hydroxide, barium hydroxide, zinc borate, zinc metaborate, calcium carbonate, molybdenum oxide, red phosphorus, a phosphate ester, ammonium polyphosphate or potassium titanate. In addition, in order to achieve the above-noted objective, the dispersibility and moisture resistance of the abovementioned flame retardant of the flexible non-halogen electric wire cable according to Claim 6 is improved by the implementation of surface processing or coupling processing using, for example, a silane coupling agent, titanate coupling agent or various types of fatty acid (stearic acid or oleic acid).

[0012] The flame retardant, which imparts flame resistance to the olefin-based resin which constitutes the base resin of the non-halogen flame-retardant sheath, is configured from one type or a mixture of two or more types of either magnesium hydroxide, aluminium hydroxide, zirconium hydroxide, calcium hydroxide, barium hydroxide, zinc borate, zinc metaborate, calcium carbonate, molybdenum oxide, red phosphorus, a phosphate ester, ammonium polyphosphate or potassium titanate. More particularly, the metal hydroxide, which is an inorganic based flame retardant employed in olefin-based resin compositions, imparts a flame-retardant action to the olefin-based resin composition, and olefin-based resin compositions formed by heat-processing without the compounding of a metal hydroxide in the olefin-based resin demonstrate no flame resistance at all. The compounding of a metal hydroxide in the olefin-based resin has the action of imparting a shape-maintaining characteristic thereto so that the olefin-based resin is difficult to burn and, when it is burned, the

embers thereof are carbonized. One of these metal hydroxides may be selected and compounded (for example, magnesium hydroxide) or two or more types thereof may be selected and compounded (for example, magnesium hydroxide and aluminium hydroxide).

[0013] The flame retardants are compounded in the amount of 50 to 200 wt. parts per 100 wt. parts of the olefin-based resin. The reason the compounded amount of the flame retardants is 50 to 200 wt. parts per 100 wt. parts of the olefin-based resin is because the prescribed flame resistance cannot be produced when the compounded amount is less than 50 wt. parts per 100 wt. parts of olefin-based resin and, in addition to the fact that increased flame resistance cannot be imparted by the compounding of the flame retardant in an amount in excess of 200 wt. parts per 100 wt. parts of the olefin-based resin, when it is compounded in an amount in excess of 200 wt. parts the durability thereof with respect to mechanical impact is reduced.

[0014] In addition, the organic chemical foaming agent is used for the purpose of foaming the olefin-based resin which constitutes the base resin of the non-halogen flame-retardant sheath and, when the organic chemical foaming agent is compounded in the olefin-based resin and extrusion-coated using an extruder, the organic chemical foaming agent is activated by the heat of the extrusion and the olefin-based resin is caused to foam. The organic chemical foaming agent is compounded in the olefin-based resin composition and the foaming rate for foaming the olefin-based resin composition is 5 to 20% and, ideally, 7 to 15%. The reason an olefin-based resin composition foaming rate due to the compounding of the organic chemical foaming agent of 5 to 20% is adopted is because satisfactory tear characteristics cannot be produced when the foaming rate is less than 5% and because, although the tear characteristics are improved when the foaming rate

exceeds 20%, the tear load at this foaming rate is too low and the prescribed physical characteristics cannot be produced. In addition, the reason the ideal olefin-based resin composition foaming rate is taken to be 7 to 15% is because the material can be easily torn if the foaming rate is 7% and, when the foaming rate exceeds 15%, significant changes in the physical characteristics of the material begin to appear.

[0015] The organic chemical foaming agent is compounded in the olefin-based resin composition in the amount of 0.2 to 5 wt. parts per 100 wt. parts of olefin-based resin composition. The reason the organic chemical foaming agent is compounded in the olefin-based resin composition in the amount of 0.2 to 5 wt. parts per 100 wt. parts of olefin-based resin composition is because, when the organic chemical foaming agent is compounded in the olefin-based resin composition in an amount less than 0.2 wt. parts per 100 wt. parts of olefin-based resin composition the foaming rate of the olefin-based resin composition is less than 5% and satisfactory tear characteristics cannot be produced and because, when the organic chemical foaming agent is compounded in the olefin-based resin composition in an amount that exceeds 5 wt. parts per 100 wt. parts of the olefin-based resin composition, although the tear characteristics are improved when the foaming rate exceeds 20%, the tear load at this foaming rate is too low and the prescribed physical characteristics cannot be produced.

[0016] Based on the invention according to Claim 3, 4, 5 and 6 configured in this way, using an olefin-based resin that does not contain a halide as the principle component, the tear load and bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted whereby the tear characteristics are improved and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0017] In addition, in order to achieve the above-noted objective, the organic chemical foaming agent compounded in the above-noted non-halogen flame-retardant sheath of the flexible non-halogen electric wire cable according to Claim 7 is configured from one type or a mixture of two or more types of either azodicarbonamide, azobis(isobutyronitrile), dinitro pentamethylene tetramine, P-toluenesulfonyl hydrazide or 4, 4' - oxybis (benzenesulfonyl hydrazide). Azodicarbonamide is an olefin-based resin foaming agent of decomposition temperature 100°C. Azobis(isobutyronitrile) is an olefin-based resin foaming agent of decomposition temperature 90 to 100°C. Furthermore, dinitro pentamethylene tetramine is a rubber foaming agent of decomposition temperature 200°C. P-toluenesulfonyl hydrazide is an olefin-based resin foaming agent of decomposition temperature 110°C. Furthermore, 4, 4' - oxybis (benzenesulfonyl hydrazide), which is an olefin-based resin foaming agent of decomposition temperature 140 to 160°C, serves both as a foaming agent and a cross-linking agent with respect to resin - rubber blends. One of these foaming agents (for example, azodicarbonamide) may be selected and compounded, or two or more types thereof (for example, azodicarbonamide and azobis(isobutyronitrile)) may be selected and compounded. When two types of foaming agent are mixed and compounded in this way, because the decomposition temperatures (foaming temperatures) of the respective foaming agents differ, the foaming time can be freely adjusted by the selective use of these foaming agents and the adjustment of the heating temperature.

[0018] Based on the invention according to Claim 7 configured in this way, the foaming time of the olefin-based resin, which constitutes the base resin of the non-halogen flame-retardant sheath, can be freely adjusted through the selection of the organic chemical foaming agent to be compounded in the non-halogen flame-retardant sheath.

[0019] Furthermore, in order to achieve the above-noted objective, the organic chemical foaming agent compound to be compounded in the above-noted non-halogen flame-retardant sheath of the flexible non-halogen electric wire cable according to Claim 8 is mixed as a master batch formed by the compounding of the organic chemical foaming agent with a mixture formed by the compounding in the olefin-based resin of the flame retardant and, in accordance with need, the compounding of other processing aids or an antioxidant. Examples of the methods for compounding the organic chemical foaming agent to be compounded in the non-halogen flame-retardant sheath that is formed to cover the exterior layer of the electric wire cable include a method in which the organic chemical foaming material is added in an unaltered state, and a method in which it is added by the mixing of a master batch formed by the compounding of a prescribed amount (for example, foaming material effective component 0.2 to 5 wt. parts) of organic chemical foaming agent in the olefin-based resin. A flame retardant, processing aid and antioxidant may be compounded in the master batch.

[0020] If a rubber additive, to produce flexibility, or a metallocene catalyst, to afford a softening of the material, is used, because an examination of the compounding of every single manufactured article must be carried out and the adjustment operations involved in this are extremely troublesome, based on the invention according to Claim 8, because a master batch of a specific foaming rate (for example 10%) is used in advance, the tear characteristics of manufactured articles of different foaming rate can be freely adjusted by the use of this master batch and the control of the added amount of this master batch, and the foaming efficiency can be altered by the increase and decrease of the added amount of the master batch so that a constant level of tear characteristics and flexibility and so on can be produced and so that the tear

characteristics are improved and the handling and processability thereof can be improved.

[0021] In addition, in order to achieve the above-noted objective, the above-noted non-halogen flame-retardant sheath of the flexible non-halogen electric wire cable according to Claim 9 is configured by the compounding in the olefin-based resin of, at the least, a flame retardant, silane coupling agent, cross-linking agent, cross-linking catalyst and organic chemical foaming agent, and the foaming at a foaming rate of 5 to 20% and cross-linking thereof. In addition, in order to achieve the above-noted objective, the compound of the above-noted organic chemical foaming agent in the flexible non-halogen electric wire cable according to Claim 10 is configured by the mixing of a master batch that is formed by the compounding of the organic chemical foaming agent, silane coupling agent, cross-linking agent and cross-linking catalyst in a compound formed by the compounding in the olefin-based resin of the flame retardant and, in accordance with need, the compounding of other processing aids or an antioxidant, and is then extrusion-covered to form a sheath. Furthermore, in order to achieve the above-noted objective, the above-noted silane coupling agent of the flexible non-halogen electric wire cable according to Claim 11 is configured from one type or a mixture of two or more types of either vinyl trimethoxy silane (VTMS), vinyl triethoxy silane, vinyl methyl diethoxy silane or vinyl phenyl dimethoxy silane. In addition, in order to achieve the above-noted objective, the above-noted cross-linking agent of the flexible non-halogen electric wire cable according to Claim 12 is configured from one type or a mixture of two or more types of either dicumyl peroxide (DCP), 2, 5 - (tertiary butyl peroxy)hexene - 3, or 1, 3 - bis(tertiary butyl peroxy isopropyl). Furthermore, in order to achieve the above-noted objective, the above-noted cross-linking catalyst of the flexible non-halogen electric wire cable

according to Claim 13 is configured from either dibutyltin dilaurate, dibutyltin dimaleate or dibutyltin methyl capsid.

[0022] The coupling agent, which is a chemical substance that is able to react with both the reinforcing material and base material of the compound material to form or promote the forming of strong bonds at the interface thereof, affords the cross-linking of the olefin-based resin molecules. Examples of the coupling agent include vinyl trimethoxy silane, vinyl triethoxy silane, vinyl methyl diethoxy silane and vinyl phenyl dimethoxy silane. A single type of the various types of coupling agent such as vinyl trimethoxy silane, vinyl triethoxy silane, vinyl methyl diethoxy silane and vinyl phenyl dimethoxy silane may be compounded (for example, vinyl trimethoxy silane) or two or more types thereof may be compounded (for example, vinyl trimethoxy silane and vinyl triethoxy silane).

[0023] Coupling agents that afford the initiation of the cross-linking between the olefin-based resin molecules in this way are cross-linking agents. The chemical cross-linking produced by these cross-linking agents constitutes a cross link produced by the compounding and heating of a cross-linking agent such as dicumyl peroxide (DCP) and, when an olefin-based resin in which a cross-linking agent has been compounded is heated, first of all, a decomposition of the cross-linking linking agent occurs due to the heat and free radicals are produced, these free radicals react with the polymer and activate the polymer so that polymer free radicals are produced, and these polymer free radicals themselves bond with each other to form a cross-linked polymer. The sheath that is extrusion-coated on the insulating body is simultaneously foamed as it is extrusion-coated due to the heat that is produced by the extrusion-coating, and the cross-linking reaction, which results in the cross-linking, occurs immediately following the foaming due to the presence of moisture in the air.

Moisture cross-linking produced by a vinyl silane involves the compounding and heating of a silane compound (coupling agent) such as a dicumyl peroxide (DCP) or vinyl trimethoxy silane (VTMS) that are free radical-generating agents (cross-linking agents), and a silanol condensation catalyst (siloxane condensation catalyst) such as dibutyltin laurate, in the olefin-based resin which constitutes the polymer. That is to say, when a polymer (olefin-based resin), cross-linking agent (dicumyl peroxide), silane compound (vinyl trimethoxy silane) and silanol condensation catalyst (dibutyltin laurate) are compounded and heat is applied thereto from the exterior, the decomposition of the cross-linking agent occurs and free radicals are produced. The free radicals and the polymer react which activates the polymer and results in the production of polymer free radicals, and these polymer free radicals and the silane compound (vinyl trimethoxy silane) react to generate graft polymers. The tin-based catalyst (dibutyltin laurate) acts on the graft polymer wherein the vinyl of the vinyl trimethoxy silane coupling agent, due to the presence of moisture, bonds with the free radicals. That is to say, because a chain is formed in a state in which the Si (silane) is contained in the molecules of a polymer (olefin-based resin) and this same phenomenon also occurs in the molecules of another polymer (olefin-based resin), a cross-linking reaction (silane cross-link) of the molecules of two polymers (olefin-resin based) occurs in a form in which oxygen (O) is formed in the centre about the Si (silane), and the molecules of the two polymers (olefin-based resin) are linked to form a cross-linked state.

[0024] Furthermore, cross-linking catalysts are used to accelerate the cross-linking phenomenon that involves the interposing of coupling agents between the olefin-based resin molecules, and examples of these cross-linking catalysts include dibutyltin dilaurate, dibutyltin diacetate and dibutyltin dioctalate.

[0025] Based on the invention according to Claim 9, 10, 11, 12 and 13 configured in this way, using an olefin-based resin that does not contain a halide as the principle component, the tear load and bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted whereby the tear characteristics are improved and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0026] In addition, in order to achieve the above-noted objective, the above-noted processing aid of the flexible non-halogen electric wire cable according to Claim 14 is configured from one or a mixture of two or more types of either methyl polymethacrylate, stearic acid or polyethylene wax. Based on the invention according to Claim 14 of this configuration, the processing of the flexible non-halogen electric wire cable can be implemented more easily.

[0027] In addition, in order to achieve the above-noted objective, the above-noted antioxidant of the flexible non-halogen electric wire cable according to Claim 15 is configured from a hindered phenol-based antioxidant or a thiobis phenol-based antioxidant. Based on the invention according to Claim 15 of this configuration, because the configuration is one in which an antioxidant is compounded in the olefin-based resin, the deterioration of the flexible non-halogen electric wire cable over time can be prevented.

[0028]

[Embodiments of the Invention] A description is given below of the embodiments of the coating material pertaining to the present invention. Figure 1 shows one embodiment of the flexible non-halogen electric wire cable pertaining to the present invention. In Figure 1, the symbol 1 refers to a conductor configured from a soft copper wire, and an insulated conductor 3 is configured by the coating of an insulating body 2 configured from a

polyvinyl chloride resin or cross-linked polyethylene on the surface of the conductor 1. An insulated power cable 10 (for example, VVF cable) is configured by the alignment of a pair of the insulated conductors 3 and the coating of a sheath 9 thereon. The sheath 9 constitutes a non-halogen flame-retardant sheath in which an olefin-based resin has been foamed. That is to say, the sheath 9 is formed by the compounding in the olefin-based resin of, at the least, a flame retardant and an organic chemical foaming agent and, in accordance with need, the compounding therein of other processing aids or an antioxidant, and the foaming thereof at a foaming rate of 5 to 20%. Furthermore, the flexible non-halogen electric wire cable from which the sheath 9 is configured may be configured by the compounding and cross-linking of a silane coupling agent, cross-linking agent and cross-linking catalyst.

[0029] Figure 2 shows another embodiment of the flexible non-halogen electric wire cable pertaining to the present invention. In Figure 2, the symbol 1 refers to a conductor configured from a soft copper wire, and an insulated conductor 3 is configured by the coating of an insulating body 2 configured from a polyvinyl chloride resin or cross-linked polyethylene on the surface of the conductor 1. An insulated power cable 11 (for example, VVR cable) is configured by the twisting of a plurality of (three in Figure 2) of the insulated conductors 3, the formation thereof in a round shape by the interposing of an inclusion 6, the winding around of a pressing wind tape 7 and the coating thereon of a sheath 9. The sheath 9 constitutes a non-halogen flame-retardant sheath in which an olefin-based resin has been foamed. That is to say, the sheath 9 is formed by the compounding in the olefin-based resin of, at the least, a flame retardant and an organic chemical foaming agent and, in accordance with need, the compounding therein of other processing aids or an antioxidant, and the foaming thereof at a foaming rate of 5 to 20%. Furthermore,

the flexible non-halogen electric wire cable from which the sheath 9 is configured may be configured by the compounding and cross-linking of a silane coupling agent, cross-linking agent and cross-linking catalyst.

[0030]

[Embodiments] A description is given below, with comparison to the examples of the prior art, of specific embodiments of the non-halogen flame-retardant sheath from which the sheath of the flexible non-halogen electric wire cable pertaining to the present invention is configured.

[0031] Embodiment 1

Embodiment 1 was produced by the compounding of 100 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) and 1 wt. part of foaming agent NO. 1 (azodicarbonamide) in 100 wt. parts of a mixture base resin comprising 70 wt. parts % of linear low density polyethylene (LLDPE, specifically, NUCG5651 manufactured by Nippon Yunika Co., Ltd.) and 30 wt. parts % of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0032] Embodiment 2

Embodiment 2 was produced by the compounding of 100 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) and 3 wt. parts of foaming agent NO. 1 (azodicarbonamide) in 100 wt. parts of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0033] Embodiment 3

Embodiment 3 was produced by the compounding of 120 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.), 0.2 wt. parts of foaming agent NO. 1 (azodicarbonamide) and 0.2 wt. parts of foaming agent NO. 2 (azobis(isobutyronitrile)) in 100 wt. parts of a mixture base resin comprising 40 wt. parts %

of linear low density polyethylene (LLDPE, specifically, NUCG5651 manufactured by Nippon Yunika Co., Ltd.) and 60 wt. parts % of metallocene-based linear low density polyethylene (metallocene-based LLPDE, specifically, Dupont Dow Elastomers EG-8440).

[0034] Embodiment 4

Embodiment 4 was produced by the compounding of 80 wt. parts of aluminium hydroxide (specifically, Hydirite 421) and 0.5 wt. parts of foaming agent NO. 1 (azodicarbonamide) in 100 wt. parts of a mixture base resin comprising 50 wt. parts % of linear low density polyethylene (LLDPE, specifically, NUCG5651 manufactured by Nippon Yunika Co., Ltd.) and 50 wt. parts % of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0035] Embodiment 5

Embodiment 5 was produced by the compounding of 50 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) and 5 wt. parts of foaming agent NO. 1 (azodicarbonamide) in 100 wt. parts of a mixture base resin comprising 90 wt. parts % of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.) and 10 wt. parts % of polypropylene (PP, specifically, J630G manufactured by JPO Co., Ltd.).

[0036] Embodiment 6

Embodiment 6 was produced by the compounding of 120 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.), 2 wt. parts of a silane coupling agent (vinyl trimethoxy silane VTMS, specifically, Tore Dauconing Silicon SZ6300), 0.1 wt. parts of cross-linking agent (dicumyl peroxide (DCP), specifically, Mitsui DCP manufactured by Mitsui Petroleum Chemicals Co., Ltd.), 0.1 wt. parts of catalyst (dibutyltin laurate, specifically BT-11 manufactured by Kyokuden Kako Co., Ltd.), 1 wt. part of processing aid (polymethyl

methacrylate (PMMA), specifically, L-1000 manufactured by Mitsubishi Rayon Co., Ltd.), and 0.2 wt. parts of foaming agent NO. 1 (azodicarbonamide) in 100 wt. parts of a mixture base resin comprising 40 wt. parts % of ethylene - vinyl acetate copolymer (EVA, specifically, NUC-3185 manufactured by Nippon Yunika Co., Ltd.) and 60 wt. parts % of metallocene-based linear low density polyethylene (metallocene-based LLPDE, specifically, Dupont Dow Elastomers EG-8440).

[0037] Embodiment 7

Embodiment 7 was produced by the compounding of 200 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.), 3 wt. parts of a silane coupling agent (vinyl trimethoxy silane VTMS, specifically, Tore Dauconing Silicon SZ6300), 0.2 wt. parts of cross-linking agent (dicumyl peroxide (DCP), specifically, Mitsui DCP manufactured by Mitsui Petroleum Chemicals Co., Ltd.), 0.2 wt. parts of catalyst (dibutyltin laurate, specifically BT-11 manufactured by Kyokuden Kako Co., Ltd.), 5 wt. parts of processing aid (polymethyl methacrylate (PMMA), specifically, L-1000 manufactured by Mitsubishi Rayon Co., Ltd.), 0.1 wt. parts of foaming agent NO. 1 (azodicarbonamide) and 0.1 wt. parts of foaming agent NO. 2 (azobis(isobutyronitrile)) in 100 wt. parts of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0038] Prior Art Example 1

Prior Art Example 1 was produced by the compounding of 100 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) in 100 wt. parts of a mixture base resin comprising 70 wt. parts % of linear low density polyethylene (LLDPE, specifically, NUCG5651 manufactured by Nippon Yunika Co., Ltd.) and 30 wt. parts % of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0039] Prior Art Example 2

Prior Art Example 2 was produced by the compounding of 100 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) in 100 wt. parts of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0040] Prior Art Example 3

Prior Art Example 3 was produced by the compounding of 120 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) in 100 wt. parts of a mixture base resin comprising 40 wt. parts % of ethylene vinyl acetate copolymer (EVA, specifically, NUC-3185 manufactured by Nippon Yunika Co., Ltd.) and 60 wt. parts % of metallocene-based linear low density polyethylene (metallocene-based LLPDE, specifically, Dupont Dow Elastomers EG-8440).

[0041] Prior Art Example 4

Prior Art Example 4 was produced by the compounding of 80 wt. parts of aluminium hydroxide (specifically, Hydirite 421) in 100 wt. parts of a mixture base resin comprising 50 wt. parts % of linear low density polyethylene (LLDPE, specifically, NUCG5651 manufactured by Nippon Yunika Co., Ltd.), 20 wt. parts % of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.) and 30 wt. parts % of ethylene - propylene copolymer (EPM, specifically, EP-02P manufacture by JSR Co., Ltd.).

[0042] Prior Art Example 5

Embodiment 5 was produced by the compounding of 50 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.) in 100 wt. parts of a mixture base resin comprising 90 wt. parts % of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.) and 10 wt. parts % of polypropylene (PP, specifically, J630G manufactured by JPO Co., Ltd.).

[0043] Prior Art Example 6

Embodiment 6 was produced by the compounding of 120 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.), 2 wt. parts of a silane coupling agent (vinyl trimethoxy silane VTMS, specifically, Tore Dauconing Silicon SZ6300), 0.1 wt. parts of cross-linking agent (dicumyl peroxide (DCP), specifically, Mitsui DCP manufactured by Mitsui Petroleum Chemicals Co., Ltd.), 0.1 wt. parts of catalyst (dibutyltin laurate, specifically BT-11 manufactured by Kyokuden Kako Co., Ltd.), and 1 wt. part of processing aid (polymethyl methacrylate (PMMA), specifically, L-1000 manufactured by Mitsubishi Rayon Co., Ltd.) in 100 wt. parts of a mixture base resin comprising 40 wt. parts % of ethylene - vinyl acetate copolymer (EVA, specifically, NUC-3185 manufactured by Nippon Yunika Co., Ltd.) and 60 wt. parts % of metallocene-based linear low density polyethylene (metallocene-based LLPDE, specifically, Dupont Dow Elastomers EG-8440).

[0044] Prior Art Example 7

Embodiment 7 was produced by the compounding of 200 wt. parts of magnesium hydroxide (specifically, Kisma PH manufactured by Kyowa Chemicals Co., Ltd.), 3 wt. parts of a silane coupling agent (vinyl trimethoxy silane VTMS, specifically, Tore Dauconing Silicon SZ6300), 0.2 wt. parts of cross-linking agent (dicumyl peroxide (DCP), specifically, Mitsui DCP manufactured by Mitsui Petroleum Chemicals Co., Ltd.), 0.2 wt. parts of catalyst (dibutyltin laurate, specifically BT-11 manufactured by Kyokuden Kako Co., Ltd.) and 5 wt. parts of processing aid (polymethyl methacrylate (PMMA), specifically, L-1000 manufactured by Mitsubishi Rayon Co., Ltd.) in 100 wt. parts of ethylene - ethyl acrylate copolymer (EEA, specifically, NUC-6070 manufactured by Nippon Yunika Co., Ltd.).

[0045] The various composition compounds based on Embodiment 1 to Embodiment 7 were introduced into an extruder of cylinder diameter 20 mm from which cord-shaped

samples of thickness 1 mm and approximate width 30 mm were produced.

[0046] Measurements of tensile strength (MPa), using a tensile test based on JIS-C3005, tear strength (N), using a tear resistance test based on JIS-K6301 and, furthermore, hardness, using the JISA hardness meter of JIS-K6301, was carried out on these samples. The comparative results thereof are shown in Table 1 and Table 2.

[0047] Table 1

			Embodiments						
			1	2	3	4	5	6	7
	Base resin (wt. parts)		100	100	100	100	100	100	100
Weight parts ratio (wt. parts%)	LLDPE		70	-	40	50	-	-	-
	EEA		30	100	-	50	90	-	100
	EVA		-	-	-	-	-	40	-
	PP		-	-	-	-	10	-	-
	Metallocene		-	-	60	-	-	60	-
	LLDPE		-	-	-	-	-	-	-
	PEM		-	-	-	-	-	-	-
Magnesium hydroxide (wt. parts)			100	100	120	-	50	120	200
Aluminium hydroxide (wt. parts)			-	-	-	80	-	-	-
Silane coupling agent (wt. parts)			-	-	-	-	-	2	3
Cross-linking agent (wt. parts)			-	-	-	-	-	0.1	0.2
Catalyst (wt. parts)			-	-	-	-	-	0.1	0.2
Processing aid (wt. parts)			-	-	-	-	-	1	5
Foaming agent No. 1			1	3	0.2	0.5	5	0.2	0.1
Foaming agent No. 2			-	-	0.2	-	-	-	0.1
Target value									
Tensile strength (MPa)			12	12	11	15	11	11	11
10 or more									

Tear strength (N)	63	45	53	48	44	55	56
70 or less							
Hardness	87	87	87	89	85	87	89
A90 or less							
Foaming rate (%)	12	20	7	9	18	6	5
Appraised result	0	0	0	0	0	0	0

LLDPE: linear low density polyethylene, NUCG5651 (Nippon Yunika Co., Ltd.)

EEA: ethylene - ethyl acrylate copolymer, NUC-6070 (Nippon Yunika Co., Ltd.)

EVA: ethylene - vinyl acetate copolymer NUC-3185 (Nippon Yunika Co., Ltd.)

PP: polyethylene, J630G (JPO Co., Ltd.)

Metallocene LLDPE: metallocene-based linear low density polyethylene, EG-8440 (Dupont Dow Elastomers)

EPM: ethylene - propylene copolymer, EP02P (JSR Co., Ltd.)

Magnesium hydroxide: Kisma PH (Kyowa Chemicals Co., Ltd.)

Aluminium hydroxide: Hydirite 421

Silane coupling agent: vinyl trimethoxy silane (VTMS), SZ6300 (Tore Dauconing Silicon)

Cross-linking agent: dicumyl peroxide DCP, Mitsui DCP (Mitsui Petroleum Chemicals Co., Ltd.)

Catalyst: dibutyltin laurate, BT-11 (Kyokuden Kako Co., Ltd.)

Processing aid: polymethyl methacrylate (PMMA), L-1000 (Mitsubishi Rayon Co., Ltd.)

Foaming agent No. 1: azodicarbonamide

Foaming agent No. 2: azobis(isobutyronitrile)

Table 2

			Prior Art Examples						
			1	2	3	4	5	6	7
	Base resin (wt. parts)		100	100	100	100	100	100	100
	Weight	LLDPE	70	-	-	50	-	-	-

parts ratio (wt. parts%)	EEA	30	100	-	20	90	-	100
	EVA	-	-	40	-	-	40	-
	PP	-	-	-	-	10	-	-
	Metallocene	-	-	60	-	-	60	-
	LLDPE	-	-	-	-	-	-	-
	PEM	-	-	-	30	-	-	-
Magnesium hydroxide (wt. parts)		100	100	120	-	50	120	200
Aluminium hydroxide (wt. parts)		-	-	-	80	-	-	-
Silane coupling agent (wt. parts)		-	-	-	-	-	2	3
Cross-linking agent (wt. parts)		-	-	-	-	-	0.1	0.2
Catalyst (wt. parts)		-	-	-	-	-	0.1	0.2
Processing aid (wt. parts)		-	-	-	-	-	1	5
Foaming agent No. 1		-	-	-	-	-	-	-
Foaming agent No. 2		-	-	-	-	-	-	-
Target value								
Tensile strength (MPa) 10 or more		15	16	8	7	18	13	12
Tear strength (N) 70 or less		125	118	55	60	153	98	93
Hardness A90 or less		98	97	88	94	96	93	99
Foaming rate (%)		0	0	0	0	0	0	0
Appraised result		x	x	x	x	x	x	x

LLDPE: linear low density polyethylene, NUCG5651 (Nippon Yunika Co., Ltd.)

EEA: ethylene - ethyl acrylate copolymer, NUC-6070 (Nippon Yunika Co., Ltd.)

EVA: ethylene - vinyl acetate copolymer NUC-3185 (Nippon Yunika Co., Ltd.)

PP: polyethylene, J630G (JPO Co., Ltd.)

Metallocene LLDPE: metallocene-based linear low density polyethylene, EG-8440 (Dupont Dow Elastomers)

EPM: ethylene - propylene copolymer, EP02P (JSR Co., Ltd.)

Magnesium hydroxide: Kisma PH (Kyowa Chemicals Co., Ltd.)

Aluminium hydroxide: Hydirite 421

Silane coupling agent: vinyl trimethoxy silane (VTMS), SZ6300 (Tore Dauconing Silicon)

Cross-linking agent: dicumyl peroxide DCP, Mitsui DCP (Mitsui Petroleum Chemicals Co., Ltd.)

Catalyst: dibutyltin laurate, BT-11 (Kyokuden Kako Co., Ltd.)

Processing aid: polymethyl methacrylate (PMMA), L-1000 (Mitsubishi Rayon Co., Ltd.)

Foaming agent No. 1: azodicarbonamide

Foaming agent No. 2: azobis(isobutyronitrile)

The measurements of tensile strength (MPa) shown in Table 1 and Table 2 were carried out using a tensile test based on JIS-C3005 as prescribed by the Japan Industrial Standards, the measurements of tear strength (N) were carried out using a tear resistance test based on JIS-K6301 as prescribed by the Japan Industrial Standards, and the measurements of hardness were performed using the JISA hardness meter of JIS-K6301 as prescribed by the Japan Industrial Standards.

[0048] The target value of the tensile strength (MPa) shown in Table 1 and Table 2, which indicates the load (MPa) at which a material can be torn into pieces and which constitutes an appraisal for determining the value of the constant strength of the material, is "10 MPa or more". In addition, the target value of the tear strength (N), which involves the tearing of the cord-shaped sample into a left and right piece and which indicates the tear load at the time of tearing, that is to say, which indicates the

maximum tear load (N) per cross-sectional area (mm^2) of the sample piece load at the time of tearing and which constitutes an appraisal for determining the value at which tearing during the laying operation of the wire is simple, is "70 N or less". Furthermore, the target value of the hardness as measured using the JISA hardness meter of JIS-K6301 as prescribed by the Japan Industrial Standards, which is generally regarded as good if it has the flexibility of a PVC sheath (hardness 90), is "A90 or less".

[0049] Embodiment 1 to Embodiment 5 shown in Table 1 refer to samples in which an olefin-based resin, in which a flame retardant (metal hydroxide) has been compounded, has been foamed using an organic chemical foaming agent, and Embodiment 6 and Embodiment 7 refer to samples in which an organic chemical foaming agent has been compounded in an olefin-based resin in which a flame retardant (metal hydroxide) has been compounded and which have been cross-linked. In contrast therewith, Embodiment 1 to Embodiment 5 shown in Table 2 refer to samples in which a flame retardant (metal hydroxide) has been compounded in an olefin-based resin, and Embodiment 6 and Embodiment 7 refer to samples in which an olefin-based resin, in which a flame retardant (metal hydroxide) has been compounded, has been cross-linked.

[0050] Next, the respective test results based on Embodiments 1 to 7 and Prior Art Examples 1 to 7 shown in Table 1 and Table 2 of tensile strength based on JIS-C3005, tear strength based on JIS-K6301 and, furthermore, hardness, using the JISA hardness meter of JIS-K6301 as prescribed by the Japan Industrial Standards were examined.

[0051] The composition components of Embodiments 1 to 7 are very similar to the Prior Art Examples 1 to 7 respectively and, accordingly, the examination of the respective test results of Embodiments 1 to 7 and Prior Art

Examples 1 to 7 was carried out using a one-to-one correspondence thereof.

[0052] Embodiment 1 and Prior Art Example 1 were both formed by the compounding of 100 wt. parts of magnesium hydroxide in 100 wt. parts of a mixture base resin comprising 70 wt. parts % of linear low density polyethylene (LLDPE) and 30 wt. parts % of ethylene - ethyl acrylate copolymer (EEA) and, in contrast to Prior Art Example 1, which was unaltered, the formation of Embodiment 1 also included the compounding of 1 wt. part of foaming agent NO. 1 (azodicarbonamide) in the olefin-based resin which contains the magnesium hydroxide, and the foaming thereof at a foaming rate of 12%. In the comparison of the tensile strength of Embodiment 1 and Prior Art Example 1, in contrast to the 15MPa tensile strength of Prior Art Example 1, the 12 MPa tensile strength of Embodiment 1, which achieves the target value tensile strength of "10 MPa or more", was also lower than that of Prior Art Example 1. In addition, in a comparison of the tear strength (N) which is indicated by the load necessary to tear the cord-shaped sample in two, in contrast to the 125N tear strength of Prior Art Example 1 which constitutes a poor tear characteristic, the 63N strength of Embodiment 1, which achieves the target tear strength value of "70N or less" which represents the value at which a material can be torn comparatively easily, indicates an improvement in tear characteristics. Furthermore, in contrast to the A98 hardness of Prior Art Example 1 that does not represent a value that approaches the flexibility of the commonly used PVC sheath, the A87 hardness of Embodiment 1 (hardness 90) indicates a flexibility that approaches that of the commonly used PVC sheath. In a summary of the above, the results for Prior Art Example 1 indicate that this sample has poor tear characteristics and a hardness that is greater than the commonly used PVC sheath and does not achieve the target values in the two aspects of tear

strength and hardness, wherein the appraisal of these values is denoted in the table by "X". In contrast to this, the results for Embodiment 1 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath and achieves the target values in the two aspects of tear strength and hardness, wherein the appraisal of these values is denoted in the table by "O". As is clear from a comparison of the composition components of Embodiment 1 and Prior Art Example 1 it is apparent that, irrespective of whether the same quantity and the same type of flame retardant are compounded in the same quantity and same type of olefin-based resin, the reason the prescribed hardness is ensured and an improvement in tear characteristics can be achieved using Embodiment 1 is due to the fact that the olefin-based resin containing the magnesium hydroxide was foamed.

[0053] Embodiment 2 and Prior Art Example 2 were both formed by the compounding of 100 wt. parts of magnesium hydroxide in 100 wt. parts of ethylene - ethyl acrylate copolymer (EEA) and, in contrast to Prior Art Example 2, which was unaltered, the formation of Embodiment 2 also included the compounding of 3 wt. parts of foaming agent NO. 1 (azodicarbonamide), and the foaming thereof at a foaming rate of 20%. In a comparison of the tensile strength of Embodiment 2 and Prior Art Example 2, in contrast to the 16 MPa tensile strength of Prior Art Example 2, the 12 MPa tensile strength of Embodiment 2, which achieves the target value tensile strength of "10 MPa or more", was also lower than that of Prior Art Example 2. In addition, in a comparison of the tear strength (N) which is indicated by the load necessary to tear the cord-shaped sample in two, in contrast to the 118N tear strength of Prior Art Example 2 which constitutes a poor tear characteristic, the 45N strength of Embodiment 2, which achieves the target tear strength value of "70N or less"

which represents the value at which a material can be torn comparatively easily, represents a substantial improvement in tear characteristics. Furthermore, in contrast to the A97 hardness of Prior Art Example 2 that does not represent a value that approaches the flexibility of the commonly used PVC sheath, the A87 hardness of Embodiment 2 (hardness 90) indicates a flexibility that approaches that of the commonly used PVC sheath. In a summary of the above, the results for Prior Art Example 2 indicate that it has poor tear characteristics and a hardness that is greater than the commonly used PVC sheath and does not achieve the target values in the two aspects of tear strength and hardness, wherein the appraisal of these values is denoted in the table by "X". In contrast to this, the results for Embodiment 2 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath and achieves the target values in the two aspects of tear strength and hardness, wherein the appraisal of these values is denoted in the table by "O". As is clear from a comparison of the composition components of Embodiment 2 and Prior Art Example 2 it is apparent that, irrespective of whether the same quantity and the same type of flame retardant are compounded in the same quantity and same type of olefin-based resin, the reason the prescribed hardness is ensured and an improvement in tear characteristics is able to be achieved using Embodiment 2 is due to the fact that the olefin-based resin containing the magnesium hydroxide was foamed.

[0054] In a comparison of Embodiment 3 and Prior Art Example 3, Embodiment 3 was formed by the compounding of 0.2 wt. parts of both the foaming agent NO. 1 (azodicarbonamide) and the foaming agent NO. 2 (azobis(isobutyronitrile)) in a compound formed by the compounding of 120 wt. parts of magnesium hydroxide in 100 wt. parts of a mixture base resin comprising 40 wt. parts %

of linear low density polyethylene (LLDPE) and 60 wt. parts % of metallocene-based linear low density polyethylene (metallocene-based LLPDE), and the foaming at a foaming rate of 7%. In addition, Prior Art Example 3 was formed by the compounding of 120 wt. parts of magnesium hydroxide in 100 wt. parts of a mixture base resin comprising 40 wt. parts % of ethylene - vinyl acetate copolymer (EVA) and 60 wt. parts % of metallocene-based linear low density polyethylene (metallocene-based LLPDE).

[0055] In a comparison of the tear strength (N) of Embodiment 3 and Prior Art Example 3 which is indicated by the load necessary to tear the cord-shaped sample in two, although the 55N tear strength of Prior Art Example 3 which constitutes a satisfactory tear characteristic, the 53N strength of Embodiment 3, which also achieves the target tear strength value of "70N or less" which represents the value at which a material can be torn comparatively easily, represents an even lower tear strength and an improvement in tear characteristics. In addition, the A88 hardness of Prior Art Example 3 represents a value that approaches the flexibility (hardness 90) of the commonly used PVC sheath, while the A87 hardness of Embodiment 3 also indicates a flexibility (hardness 90) that approaches that of the commonly used PVC sheath. Although both Embodiment 3 and Prior Art Example 3 satisfy the target values for tear strength and hardness in this way, in a comparison of tensile strength, while the 11MPa tensile strength of Embodiment 3 satisfies the tensile strength target value of "10MPa or more", the results show that the 8MPa tear strength of Prior Art Example 3 is less than the target tear strength value of "10MPa or more" and, accordingly, lacks the required tensile strength.

[0056] Accordingly, in a summary thereof, while the results for Prior Art Example 3 indicate that it has satisfactory tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath, it does

not achieve the target value in the aspect of tensile strength and, accordingly, this is denoted in the table by "X". In contrast to this, the results for Embodiment 3 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath and achieves the target values in the two aspects of tear strength and hardness, wherein the appraisal of these values is denoted in the table by "O". As is clear from the test results for Prior Art Example 3 it is apparent that, although the prescribed target tear characteristics and flexibility can be produced when an ethylene - vinyl acetate copolymer (EVA) is employed as the base resin in order to improve the tear characteristics and to impart the flexibility of the commonly used PVC sheath, the tensile strength is lowered when this is employed wherein, as the tensile strength for an electric wire sheath is unable to be produced, it is unsuitable for use as an electric wire sheath material. In contrast to this, it is clear in Embodiment 3 that the tear characteristics are improved and the flexibility of that of the commonly used PVC sheath is imparted by the foaming of the base resin and the compounding of a linear low density polyethylene (LLDPE) to impart the prescribed tensile strength.

[0057] In a comparison of Embodiment 4 and Prior Art Example 4, Embodiment 4 was formed by the compounding of 0.5 wt. parts of foaming agent NO. 1 (azodicarbonamide) in a compound formed by the compounding of 80 wt. parts of magnesium hydroxide in 100 wt. parts of a mixture base resin comprising 50 wt. parts % of linear low density polyethylene (LLDPE) and 50 wt. parts % of ethylene - ethyl acrylate copolymer (EEA), and the foaming thereof at a foaming rate of 9%. In addition, Prior Art Example 4 was formed by the compounding of 80 wt. parts of magnesium hydroxide in 100 wt. parts of a mixture base resin comprising 50 wt. parts % of linear low density

polyethylene (LLDPE), 20 wt. parts % of ethylene - ethyl acrylate copolymer (EEA), and 30 wt. parts % of ethylene - propylene copolymer (EPM).

[0058] In a comparison of the tear strength (N) of Embodiment 4 and Prior Art Example 4 which is indicated by the load necessary to tear the cord-shaped sample in two, while the 60N tear strength of Prior Art Example 3 (sic) constitutes a satisfactory tear characteristic the 48N strength of Embodiment 3 (sic), which also achieves the target tear strength value of "70N or less" which represents the value at which a material can be torn comparatively easily, represents an even lower tear strength and an improvement in tear characteristics. In addition, the A94 hardness of Prior Art Example 4 represents a value that approaches the flexibility (hardness 90) of the commonly used PVC sheath and the A89 hardness of Embodiment 4 also indicates a flexibility (hardness 90) that approaches that of the commonly used PVC sheath. Although Prior Art Example 4 has very good tear characteristics it has high hardness and a 7MPa tensile strength that indicates brittleness. In contrast to this, Embodiment 4 has very good tear characteristics, a hardness that satisfies the target value of "A90 or less", and a 15MPa tensile strength that indicates there is no brittleness. Accordingly, in a summary thereof, the results for Prior Art Example 4 indicate that it does not achieve the target values in the aspects of hardness and tensile strength, wherein the appraisal of these values is denoted in the table by "X". In contrast to this, the results for Embodiment 4 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath, wherein the appraisal of these values is denoted in the table by "O". As is clear from the test results for Embodiment 4 and Prior Art Example 4 it is apparent that, irrespective of whether the same type of flame retardant is

compounded in the same quantity, the reason the prescribed hardness was ensured and an improvement in tear characteristics was able to be achieved using Embodiment 4 was due to the fact that the base resin was foamed. It is thought that the tear characteristics were able to be improved using Prior Art Example 4 due to the compounding of an ethylene - propylene copolymer (EPM) and that, against this improvement in tear characteristics, there was an increase in brittleness (reduction in tensile strength).

[0059] Embodiment 5 and Prior Art Example 5 were both formed by the compounding of 50 wt. parts of magnesium hydroxide in 100 wt. parts of a mixture base resin comprising 90 wt. parts % of ethylene - ethyl acrylate copolymer (EEA) and 10 wt. parts % of polypropylene (PP) and, in contrast to Prior Art Example 5, which was unaltered, the formation of Embodiment 5 also included the compounding of 5 wt. parts of foaming agent NO. 1 (azodicarbonamide) in the olefin-based resin which contains the magnesium hydroxide, and the foaming thereof at a foaming rate of 18%. In a comparison of the tensile strength of Embodiment 5 and Prior Art Example 5, in contrast to the 18MPa tensile strength of Prior Art Example 5, the 11 MPa tensile strength of Embodiment 5 which, along with Prior Art Example 5, achieves the target value tensile strength of "10 MPa or more", was lower than that of Prior Art Example 5. In addition, in a comparison of the tear strength (N) which is indicated by the load necessary to tear the cord-shaped sample in two, in contrast to the 153N tear strength of Prior Art Example 5 which constitutes a poor tear characteristic, the 44N strength of Embodiment 5, while easily achieving the target tear strength value of "70N or less" which represents the value at which a material can be torn comparatively easily, indicates an improvement in tear characteristics. Furthermore, in contrast to the A96 hardness of Prior Art Example 5, which does not represent a value that approaches the flexibility

of the commonly used PVC sheath, the A85 hardness of Embodiment 5 (hardness 90) indicates a flexibility that approaches that of the commonly used PVC sheath. In a summary of the above, the results for Prior Art Example 5 indicate that it has poor tear characteristics and is harder than the commonly used PVC sheath and, while it satisfies the tear strength, it does not achieve the target values in the two aspects of tear strength and hardness, wherein the appraisal of these results are denoted in the table by "X". In contrast to this, the results for Embodiment 5 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath and it achieves the target values in, in addition to the tensile strength, the two aspects of tear strength and hardness, wherein the appraisal of these results is denoted in the table by "O". As is clear from the comparison of the composition components of Embodiment 5 and Prior Art Example 5 it is apparent that, irrespective of whether the same quantity and the same type of flame retardant was compounded in the same quantity and same type of olefin-based resin, the reason the prescribed hardness is ensured and an improvement in tear characteristics is able to be achieved using Embodiment 5 is due to the fact that the olefin-based resin containing the magnesium hydroxide was foamed.

[0060] Embodiment 6 and Prior Art Example 6 were both formed by the compounding and cross-linking of 120 wt. parts of magnesium hydroxide, 2 wt. parts of a silane coupling agent (vinyl trimethoxy silane), 0.1 wt. parts of cross-linking agent (dicumyl peroxide (DCP), 0.1 wt. parts of catalyst (dibutyltin laurate), and 1 wt. part of processing aid (polymethyl methacrylate (PMMA) in 100 wt. parts of a mixture base resin comprising 40 wt. parts % of ethylene - vinyl acetate copolymer (EVA) and 60 wt. parts % of metallocene-based linear low density polyethylene

(metallocene-based LLPDE) and, in contrast to Prior Art Example 6, which was unaltered, the formation of Embodiment 6 also included the compounding of 0.2 wt. parts of foaming agent NO. 1 (azodicarbonamide) in the olefin-based resin which contains the magnesium hydroxide, and the foaming thereof at a foaming rate of 6%. In a comparison of the tensile strength of Embodiment 6 and Prior Art Example 6, in contrast to the 13MPa tensile strength of Prior Art Example 6, the 11 MPa tensile strength of Embodiment 6 which, along with Prior Art Example 6, achieves the target value tensile strength of "10 MPa or more", was lower than that of Prior Art Example 6. In addition, in a comparison of the tear strength (N) which is indicated by the load necessary to tear the cord-shaped sample in two, in contrast to the 98N tear strength of Prior Art Example 6 which constitutes a poor tear characteristic, the 55N strength of Embodiment 6, while easily achieving the target tear strength value of "70N or less" which represents the value at which a material can be torn comparatively easily, indicates an improvement in tear characteristics. Furthermore, in contrast to the A93 hardness of Prior Art Example 6 that does not represent a value that approaches the flexibility of the commonly used PVC sheath, the A87 hardness of Embodiment 6 (hardness 90) indicates a flexibility that approaches that of the commonly used PVC sheath. In a summary of the above, the results for Prior Art Example 6 indicate that it has poor tear characteristics and is harder than the commonly used PVC sheath and, while it satisfies the tear strength, it does not achieve the target values in the two aspects of tear strength and hardness, wherein the appraisal of these results are denoted in the table by "X". In contrast to this, the results for Embodiment 6 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath and achieves the target values in,

in addition to the tensile strength, the two aspects of tear strength and hardness, wherein the appraisal of these results which is denoted in the table by "O". As is clear from a comparison of the composition components of Embodiment 6 and Prior Art Example 6 it is apparent that, irrespective of whether the same quantity and the same type of flame retardant was compounded in the same quantity and same type of olefin-based resin, the reason the prescribed hardness is ensured and an improvement in tear characteristics is able to be achieved using Embodiment 6 is due to the fact that the olefin-based resin containing the magnesium hydroxide was foamed.

[0061] Although in both Prior Art Example 3 and Prior Art Example 6 the same quantity and same amount of flame retardant are compounded in the same type and same quantity of olefin-based resin, the 13MPa tensile strength of Prior Art Example 6 is different to the 8MPa tensile strength of Prior Art Example 3, the 98N tear strength of Prior Art Example 6 is different to the 55N tear strength of Prior Art Example 3, and the A93 hardness of Prior Art Example 6 is different to the A88 hardness of Prior Art Example 3. This is interpreted as being as a result of the fact that, in contrast to the base resin of Prior Art Example 3 that is not cross-linked, the base resin of Prior Art Example 6 is cross-linked. Generally, when the base resin is cross-linked, the tensile strength and hardness of the base resin increase.

[0062] Embodiment 7 and Prior Art Example 7 were both formed by the compounding of 200 wt. parts of magnesium hydroxide, 3 wt. parts of a silane coupling agent (vinyl trimethoxy silane), 0.2 wt. parts of cross-linking agent (dicumyl peroxide (DCP), 0.2 wt. parts of catalyst (dibutyltin laurate), and 5 wt. parts of processing aid (polymethyl methacrylate (PMMA) in 100 wt. parts of ethylene - ethyl acrylate copolymer (EEA) and, in contrast to Prior Art Example 7, which was unaltered, the formation

of Embodiment 7 also included the compounding of 0.1 wt. parts of both foaming agent NO. 1 (azodicarbonamide) and foaming agent NO. 2 (azobis(isobutyronitrile)) respectively, and the foaming thereof at a foaming rate of 5%. In a comparison of the tensile strength of Embodiment 7 and Prior Art Example 7, in contrast to the 12MPa tensile strength of Prior Art Example 7, the 11 MPa tensile strength of Embodiment 7 which, along with Prior Art Example 7 achieves the target value tensile strength of "10 MPa or more", represents a value that is slightly lower than that of Prior Art Example 7. In addition, in a comparison of the tear strength (N) which is indicated by the load necessary to tear the cord-shaped sample in two, in contrast to the 93N tear strength of Prior Art Example 7 which constitutes a poor tear characteristic, the 56N strength of Embodiment 7, while easily achieving the target tear strength value of "70N or less" which represents the value at which a material can be torn comparatively easily, indicates an improvement in tear characteristics.. Furthermore, in contrast to the A99 hardness of Prior Art Example 7 that does not represent a value that approaches the flexibility of the commonly used PVC sheath, the A89 hardness of Embodiment 7 (hardness 90) indicates a flexibility that approaches that of the commonly used PVC sheath. In a summary of the above, the results for Prior Art Example 7 indicate that it has poor tear characteristics and is harder than the commonly used PVC sheath and, while it satisfies the tear strength, it does not achieve the target values in the two aspects of tear strength and hardness, wherein the appraisal of these results are denoted in the table by "X". In contrast to this, the results for Embodiment 7 show that it has satisfactory tensile strength, good tear characteristics and a flexibility that is equivalent to that of the commonly used PVC sheath and achieves the target values in, in addition to the tensile strength, the two aspects of

tear strength and hardness, wherein the appraisal of these results is denoted in the table by "O". As is clear from the comparison of the composition components of Embodiment 7 and Prior Art Example 7 it is apparent that, irrespective of whether the same quantity and the same type of flame retardant was compounded in the same quantity and same type of olefin-based resin, the reason the prescribed hardness was able to be ensured and an improvement in tear characteristics was able to be achieved using Embodiment 7 was due to the fact that the olefin-based resin containing the magnesium hydroxide was foamed.

[0063]

[Effect of the Invention] The present invention, by virtue of the fact that is configured in the manner described above, affords the effects described below.

[0064] Based on the invention according to Claim 1, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved.

[0065] Based on the invention according to Claim 2, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved.

[0066] Based on the invention according to Claim 3, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0067] Based on the invention according to Claim 4, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0068] Based on the invention according to Claim 5, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0069] Based on the invention according to Claim 6, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0070] Based on the invention according to Claim 7, the foaming time of the olefin-based resin, which constitutes the base resin of the non-halogen flame-retardant sheath, can be freely adjusted through the selection of the organic chemical foaming agent for compounding in the non-halogen flame-retardant sheath.

[0071] Based on the invention according to Claim 8, because a master batch of specific foaming rate (for example 10%) is formed in advance, the tear characteristics of manufactured products of different foaming rate can be freely adjusted by the use of this master batch and by controlling the added amount of the master batch and, by the free alteration of the foaming efficiency by increasing or decreasing the added amount of the master batch, tear characteristics and flexibility of a constant level can be

produced so that the tear characteristics and the handling and processability can be improved.

[0072] Based on the invention according to Claim 9, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0073] Based on the invention according to Claim 10, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0074] Based on the invention according to Claim 11, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0075] Based on the invention according to Claim 12, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0076] Based on the invention according to Claim 13, using an olefin-based resin that does not contain a halide as the principle component, the tear load and the bending load are suppressed and the prescribed tear load and the prescribed bending load are imparted so that the tear

characteristics and the handling and processability can be improved, and the standard flame resistance can be ensured.

[0077] Based on the invention according to Claim 14, the processing of the non-halogen flame-retardant sheath can be implemented more easily.

[0078] Based on the invention according to Claim 15, deterioration of the non-halogen flame-retardant sheath over time can be prevented.

[Brief Description of the Diagrams]

[Figure 1] is a cross-sectional diagram that shows an embodiment of a two-wire insulated power cable pertaining to the present invention;

[Figure 2] is a cross-sectional diagram that shows an embodiment of a multi-wire insulated power cable pertaining to the present invention;

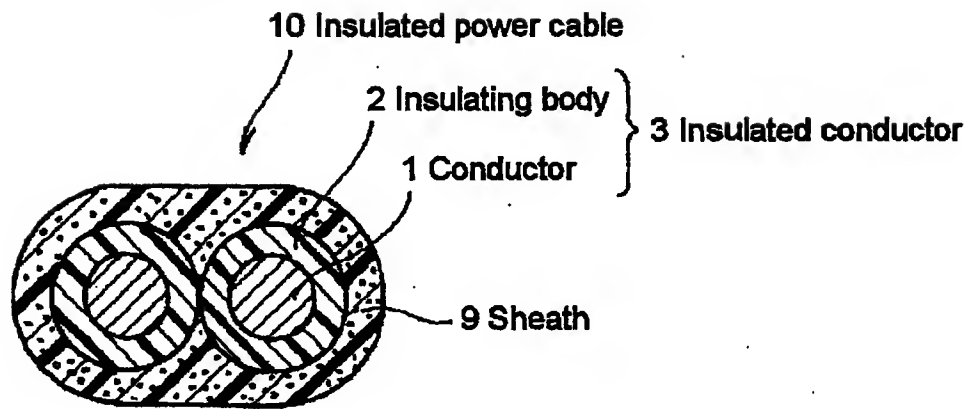
[Figure 3] is a cross-sectional diagram that shows an embodiment of a two-wire insulated power cable pertaining to the present invention; and

[Figure 4] is a cross-sectional diagram that shows an embodiment of a multi-wire insulated power cable pertaining to the present invention.

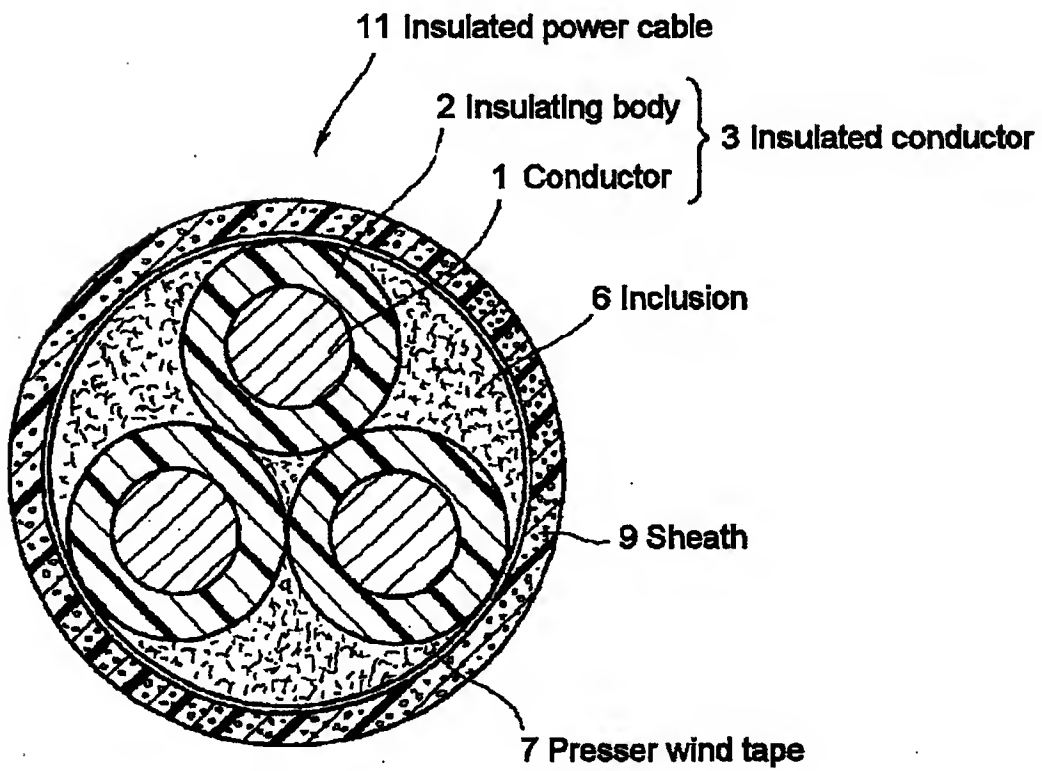
[Explanation of Symbols]

- | | |
|--------|-----------------------|
| 1 | Conductor |
| 2 | Insulating body |
| 3 | Insulated conductor |
| 6 | Inclusion |
| 7 | Presser wind tape |
| 9 | Sheath |
| 10, 11 | Insulated power cable |

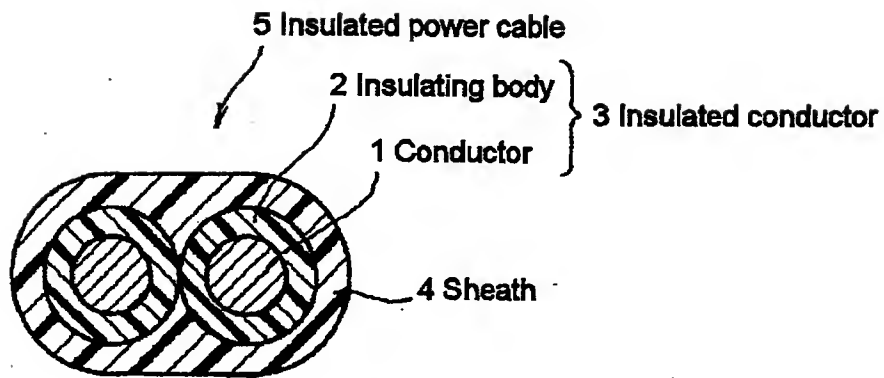
[Fig. 1]



[Fig. 2]



[Fig. 3]



[Fig. 4]

